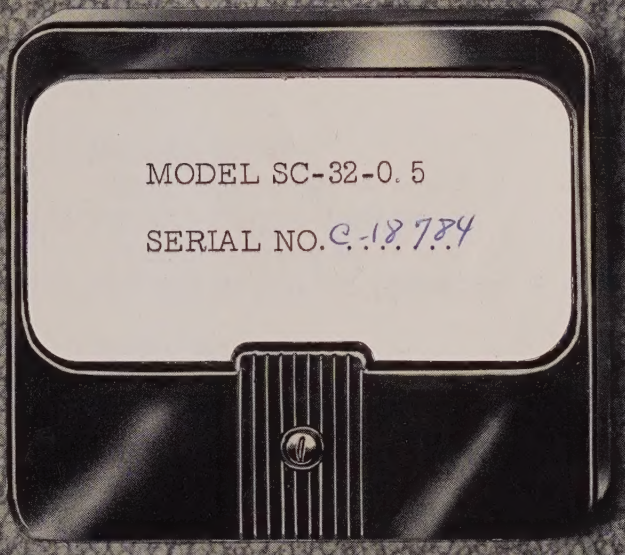
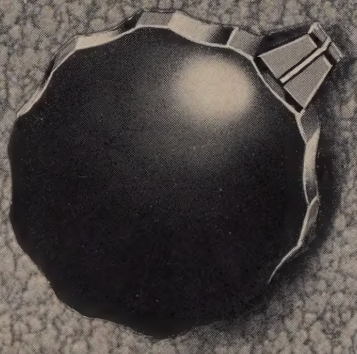
first in Performance Reliability and Quality

Kepco INSTRUCTION MANUAL

VRPS*





* VOLTAGE REGULATED POWER SUPPLIES

Kepco

MODEL SC-32-0.5

SERIAL NO. C-1878

KEPCO, INC.
131 - 38 Sanford Avenue
Flushing 55, New York

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Kepco, Inc.
Flushing, New York

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Schematic Diagrams of Power and Control Units

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SECTION A

SPECIFICATIONS AND CONTROLS

I. ELECTRICAL AND PHYSICAL SPECIFICATIONS:

.....DC OUTPUT VOLTAGE:

0-32 volts DC, continuously variable.

.....DC OUTPUT CURRENT:

0-0.5 amperes, continuous duty.

.....AC INPUT:

105-125 volts AC, 50-65 CPS, 1.3 amperes maximum.

.....REGULATION:

Line: Less than 0.01% for line change 105-125 volts AC at any output voltage in the specified range.

Load: Less than 0.01% or 0.002 volt, whichever is greater, for load change 0 to maximum, at any output voltage in the specified range.

.....RIPPLE:

0.001 volt RMS.

.....STABILITY:

Output voltage variation less than 0.01% or 0.002 volt, whichever is greater, over a period of 8 hours after unit has reached equilibrium. Approximately 3/4 of an hour is required for this unit to reach equilibrium from a "cold start".

.....OUTPUT IMPEDANCE:

Less than 0.02 ohm from DC to 1 KC.

Less than 0.2 ohm from 1 KC to 100 KC.

.....RECOVERY TIME:

50 microseconds.

.....TEMPERATURE COEFFICIENT:

Output voltage changes less than 0.01% per °C.

.....AMBIENT OPERATING TEMPERATURE:

50°C maximum. Protective circuit turns off unit whenever over-temperature condition occurs. Unit is reset by interrupting input.

.....STORAGE TEMPERATURE:

-40°C to +85°C.

.....DIMENSIONS:

Height 3-1/2", width 19", depth 13".

.....COLOR:

Kepco standard gray hammertone.

.....METERS:

Voltmeter: 0-50 volts, 2-1/2" wide view.

Ammeter: 0-0.5 amperes, 2-1/2" wide view.

II. TERMINALS AND CONTROLS:

(On Front Panel):

1. DC OUTPUT and ground terminals marked and isolated from chassis. Either positive or negative terminal may be grounded.

2. 10 turn voltage control, 0.005% resolution.

3. AC input power ON-OFF switch.

(On rear of Unit):

1. DC OUTPUT and ground terminals.

2. Two remote ERROR SENSING terminals on rear terminal board enable regulation to be maintained directly at the load by providing a means of compensating for voltage drops across the load supply leads. (See Diagram and Procedure on Page C-1).

3. Two remote OUTPUT VOLTAGE CONTROL terminals on rear terminal board enable output voltage to be controlled remotely at approximately 300 ohms/volt (i.e. for each 300 ohms change in a remote control resistance, the output voltage changes by approximately one volt). (See Diagram and Procedure on Page C-2.)

4. CURRENT LIMIT ADJUST (CL) screwdriver adjustment on the Control Unit (TRAM) provides a means of setting the current limit at any value in the range from 0 to 120% of rated full load current. As a safety feature, this unit has been designed to automatically limit at 120% of rated full load current so that the wattage dissipation of the series pass transistors is never exceeded.

NOTE: As the current limit is approached, regulation deteriorates slightly. Consequently, for best regulation throughout the operating load current range, the Current Limit Adjust should be set about 25% higher than the desired maximum output current.

ADDITIONAL FEATURES:

5. Maximum Current Adjust: The screwdriver adjustment on the Control Unit is factory set at the maximum safe current limit for the unit. THIS SETTING SHOULD NOT BE CHANGED UNLESS FULL RATED LOAD CURRENT CANNOT BE OBTAINED WHEN THE POWER SUPPLY IS CONNECTED FOR REMOTE ERROR SENSING WITH LONG SENSING LEADS. In this special case, the current supplied to the load will be limited to less than 120% by the amount of voltage drop in the sensing leads unless the following steps are taken:

a) Load the supply with a remotely connected resistor which will draw slightly more than 120% of the rated supply current.

b) Turn the Current Limit Adjust to maximum clockwise.

c) Turn Maximum Current Adjust clockwise until the current is exactly 120% of rated supply current.

d) Turn Current Limit Adjust counter-clockwise to limit at desired current value.

6. Constant Current Operation: Without internal modification.

(See Diagram and Procedure on Page C-3.)

SECTION B.

THEORY OF OPERATION

The object of the following discussion is to obtain a brief qualitative view of some of the fundamental functional relationships among the elements of this power supply. A system of nomenclature has been introduced into this discussion solely to facilitate reference to the schematic circuitry. This nomenclature appears directly on the schematic diagrams in the REFERENCE INDEX. It should be recognized that terminology adopted for this purpose is only an internal standardization of the manufacturer but, as much as possible, the attempt has been made to conform to accepted engineering usage.

This power supply is of a servo or closed loop design in which the pass elements are in series with the load. The block diagram below demonstrates this.

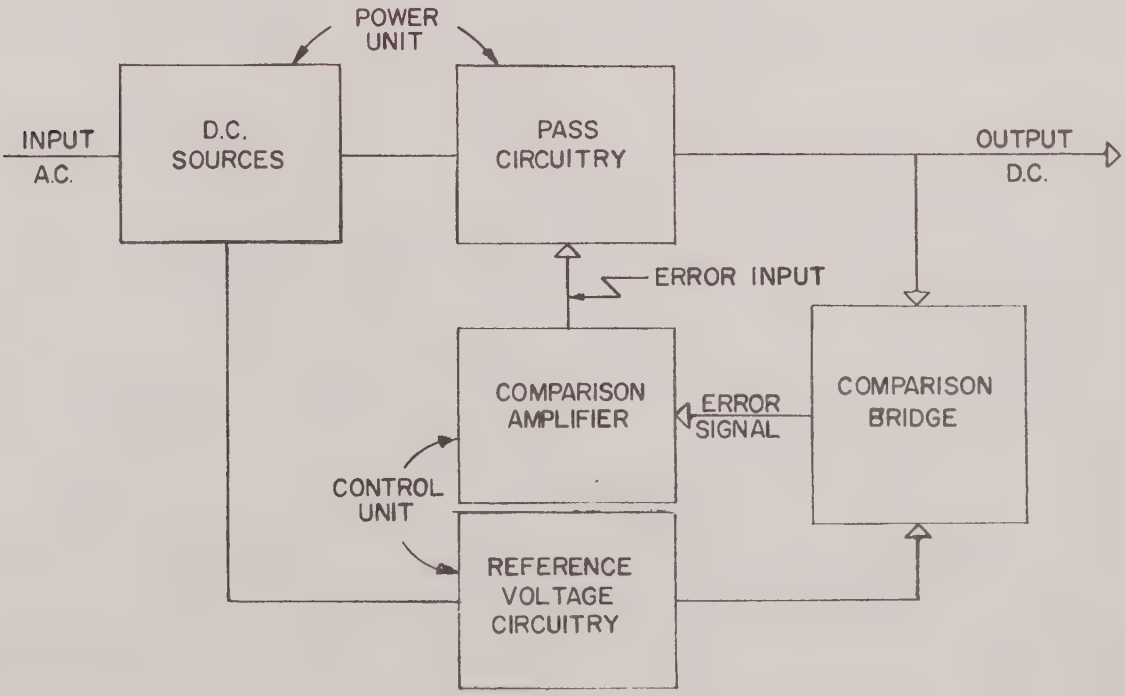


DIAGRAM B-1

The voltage drops in the closed loop are automatically adjusted according to the comparison of a sample output voltage with the reference voltage in the CONTROL UNIT*. Any imbalance originating in this comparison is amplified and functions as a feedback or ERROR INPUT* to control the voltage drop across the pass transistors. The ERROR INPUT* to the PASS CIRCUITRY* is negatively or degeneratively phased so that the consequent voltage drop across the pass transistors is such as to oppose output voltage change.

ALL "ASTERISKED" TERMS IN THE FOLLOWING OUTLINE REFER TO DESIGNATIONS ON THE SCHEMATICS IN THE REFERENCE INDEX.

..... I. POWER UNIT* (Schematic Title)

consisting of:

A. INPUT CONTROL CIRCUITRY* - Controls power input from the line to the DC SOURCES* - transformers.

B. DC SOURCES* - Provide main and auxiliary power for all DC circuitry.

C. PASS CIRCUITRY* - In the MAIN DC* path to the output. All current drawn by the load goes through the pass elements, hence the name.

..... II. CONTROL UNIT* (Schematic Title)

consisting of:

A. REFERENCE VOLTAGE CIRCUITRY* - Maintains a stable voltage standard for the comparison circuitry.

B. THE COMPARISON AMPLIFIER* - Functions as an "error sensing" and cascade amplification circuit.

.....III. COMPARISON BRIDGE*

consisting of elements of both the POWER UNIT* and CONTROL UNIT* in a circuit configuration which effects a comparison between a sample of output voltage and a stable reference voltage.

- - - - - - - - - - - - - - - -

NOTE: The following discussion describes the elements of the foregoing outline in greater detail. As before, terms followed by an asterisk refer to designations on the schematic diagrams. Some of this discussion is of a general nature and may not apply in every detail to this specific model. Variations in the basic outline occur primarily in connection with the PASS CIRCUITRY* or the REFERENCE VOLTAGE CIRCUITRY* and reflect design considerations relevant to the particular output requirements of the model. It should not be assumed that a set of schematics is incomplete because it does not include all of the reference nomenclature used in this discussion.

.....I. POWER UNIT*

A. INPUT CONTROL CIRCUIT*:

(1) INPUT RELAY* automatically interrupts the power input to DC SOURCES whenever the thermostat control detects overheating in the PASS CIRCUITRY*. This relay is normally open. When

it is thrown in response to an over-temperature condition, it provides a discharge path for the MAIN FILTER* capacitor.

(2) OVERVOLTAGE RELAY* provides a discharge path for the MAIN FILTER* capacitor whenever the line input is interrupted.

(3) DISCHARGE RESISTOR* - When the input to the DC SOURCES is opened by interrupted line power or the action of the thermostat control, the DISCHARGE RESISTOR* effectively shorts the MAIN FILTER* capacitor. This prevents overvoltage surges.

B. DC SOURCES*:

(1) RETURN SUPPLY* (full wave rectified and filtered) - Provides a return path for leakage current (I_{CO}) from the pass transistors. It is also a bleed path which provides a minimum operating current for the emitters of the pass transistors, enabling them to continue to remain operative or "sensitive" to the ERROR INPUT* when the load current becomes zero or vanishingly small.

(2) MAIN SUPPLY* (full wave rectified and filtered) - Provides MAIN DC* for the output, subject to the regulatory action of the PASS CIRCUITRY*. The MAIN DC* path includes the pass elements and the load in series.

(3) I_{CO} SUPPLY* (full wave rectified) - Provides a supply of current to prevent spurious biasing of the pass transistors by collector leakage current (I_{CO}). I_{CO} generated as a function of temperature and flowing oppositely to the emitter base current tends to alter the ERROR INPUT* unless this compensating supply provides bias stabilization.

(4) COLLECTOR SUPPLIES* (negative half-cycle rectification) - provide proper collector bias for the PRE-DRIVERS*.

C. PASS CIRCUITRY*:

The power transistors which function as pass elements may be regarded as electronic variable resistors (or variable conductors) controlled or "varied" by an amplified ERROR INPUT*. The amount of current "passed" by these transistors is a function of the magnitude of the forward conducting emitter-base bias. Since the ERROR INPUT* is applied to the base terminal, a negative input will aid the forward conducting bias of a PNP transistor while a positive input will reduce the forward conducting bias. Responding to the polarity and magnitude of the ERROR INPUT*, the pass transistors regulate the current and voltage distribution in the MAIN DC* loop and effect a constant output voltage.

There are two main classifications of pass transistors in this circuitry according to the way in which they are driven:

(1) DRIVEN PASS* - "driven" by the ERROR INPUT from the CONTROL UNIT*. A DRIVER* and a PRE-DRIVER* may be connected in cascade with the DRIVEN PASS*. These amplification stages increase the response and sensitivity of the system to output voltage changes. The DRIVEN PASS* may be a single series pass transistor or a series pass group of transistors connected in parallel.

(2) SLAVE PASS* - found in transistorized units requiring more than one series pass group in the MAIN DC* path. These pass transistors "slavishly" follow the response of the DRIVEN PASS* to the ERROR INPUT*. The SLAVE PASSES* are driven through a SLAVE VOLTAGE DIVIDER* which effects an approximately equal voltage division among the series pass groups, each of which may be a single series pass transistor or a series pass group of transistors connected in parallel. The SLAVE PASSES* may or may not have preliminary amplification stages in cascade.

- - - - - - - - - - - -

When series pass groups contain transistors connected in parallel, an EQUALIZING RESISTOR* is associated with each transistor. These EQUALIZING RESISTORS* tied to each emitter provide self-biasing compensation for intrinsic operating characteristic differences, equalizing current distribution among the transistors.

The expression "drop voltage" is sometimes used to describe the amount of voltage drop required of the pass elements to bring the COMPARISON BRIDGE into balance. This, of course, is the difference

between the input and the desired output. True balance or stability is inherently impossible in a servo system, but the imbalance may be reduced to as small a magnitude as desired in a dynamically corrective system.

II. CONTROL UNIT*

A. REFERENCE VOLTAGE CIRCUITRY:*

The function of the REFERENCE VOLTAGE CIRCUITRY* is to maintain a precise, stable voltage for the COMPARISON BRIDGE. This is achieved according to the type of CONTROL UNIT* with either of two basic design approaches:

(1) A CASCADE ZENER REFERENCE*, consisting of Zener diodes of successively decreasing values in cascaded stages each of which produce an increasingly regulated reference voltage. In practice, usually only two stages are used so that in effect the first Zener diode is a regulator for a voltage reference diode.

(2) Balanced amplifier regulation - Any disparity between the bases of the transistors in the set of 1st BALANCED AMPLIFIERS* is coupled to the set of 2nd BALANCED AMPLIFIERS*. The 2nd BALANCED AMPLIFIERS* couple this amplified "error signal" to a REFERENCE DRIVER* and a REFERENCE PASS* which regulate the current through a REFERENCE DIODE* in a manner analogous to the action of the PASS CIRCUITRY* in the POWER UNIT*.

B. COMPARISON AMPLIFIER CIRCUITRY*:

(1) The COMPARISON AMPLIFIER* consists of a series of cascaded transistor amplifiers which boost the "error input" to a sufficient level to drive the PASS CIRCUITRY* in the POWER UNIT*.

(2) The COMPARISON AMPLIFIER* is connected across the COMPARISON BRIDGE from the junction of the VOLTAGE CONTROL* and the REFERENCE RESISTANCE* to the junction of the Zener reference diode and the negative output terminal. (See Diagram B-2.) This situation is somewhat similar to that of the null galvanometer across a Wheatstone bridge. The imbalance in the COMPARISON BRIDGE is detected and amplified by the COMPARISON AMPLIFIER CIRCUITRY* beginning a chain of circuit responses which produce an ERROR INPUT* signal of proper phase and magnitude to effect corrective action by the pass circuitry.

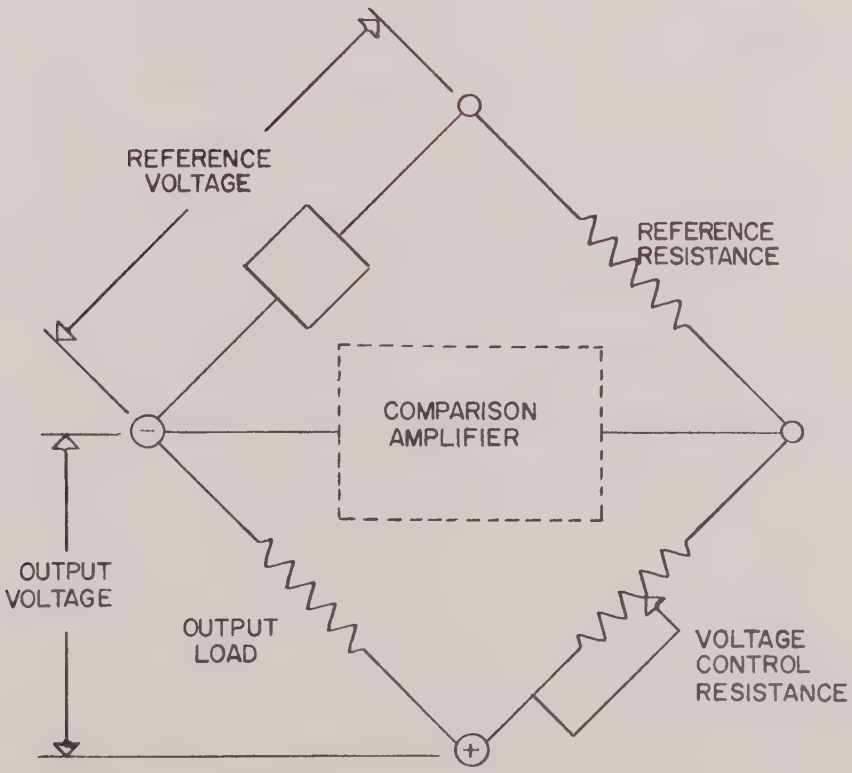


DIAGRAM B-2

.....III. COMPARISON BRIDGE:

(1) This bridge circuit implements the comparison between the OUTPUT VOLTAGE and the REFERENCE VOLTAGE the product of which drives the COMPARISON AMPLIFIER CIRCUITRY*.

(2) The COMPARISON BRIDGE is represented schematically in Diagram B-2.

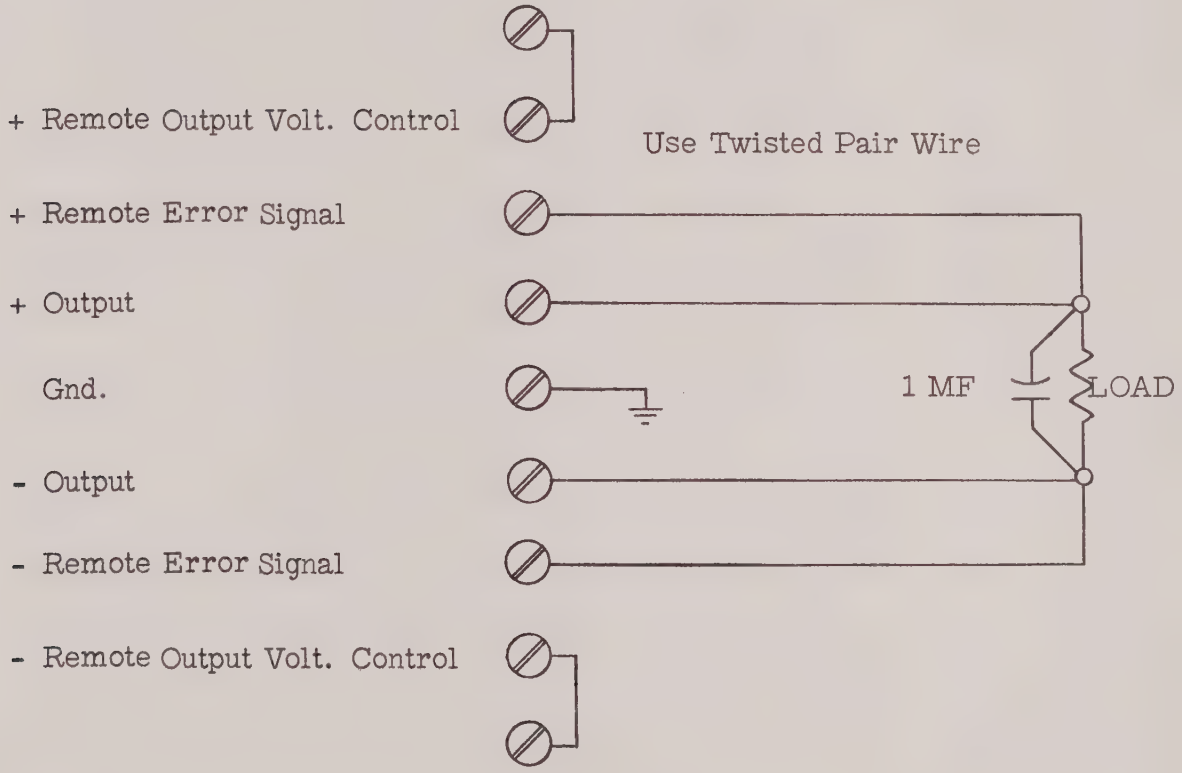
(3) Balance occurs in the COMPARISON BRIDGE when the following ratios are equal:

$$\frac{\text{Output Voltage}}{\text{Voltage Control Resistance}} = \frac{\text{Reference Voltage}}{\text{Reference Resistance}}$$

(4) When an imbalance is caused in the COMPARISON BRIDGE by a decreasing output voltage drop across the load, it gives rise to a negative bias at the base of the COMPARISON FOLLOWER* in the COMPARISON AMPLIFIER CIRCUITRY*. This signal, amplified, acting as the ERROR INPUT* negatively biases the base of the DRIVEN PASS* aiding its forward conducting bias and increasing the output voltage.

(5) A bridge imbalance caused by an increasing output voltage produces, of course, a chain of oppositely biased circuit responses which reduce the voltage across the load.

CONVERTING TO REMOTE ERROR SIGNAL OPERATION

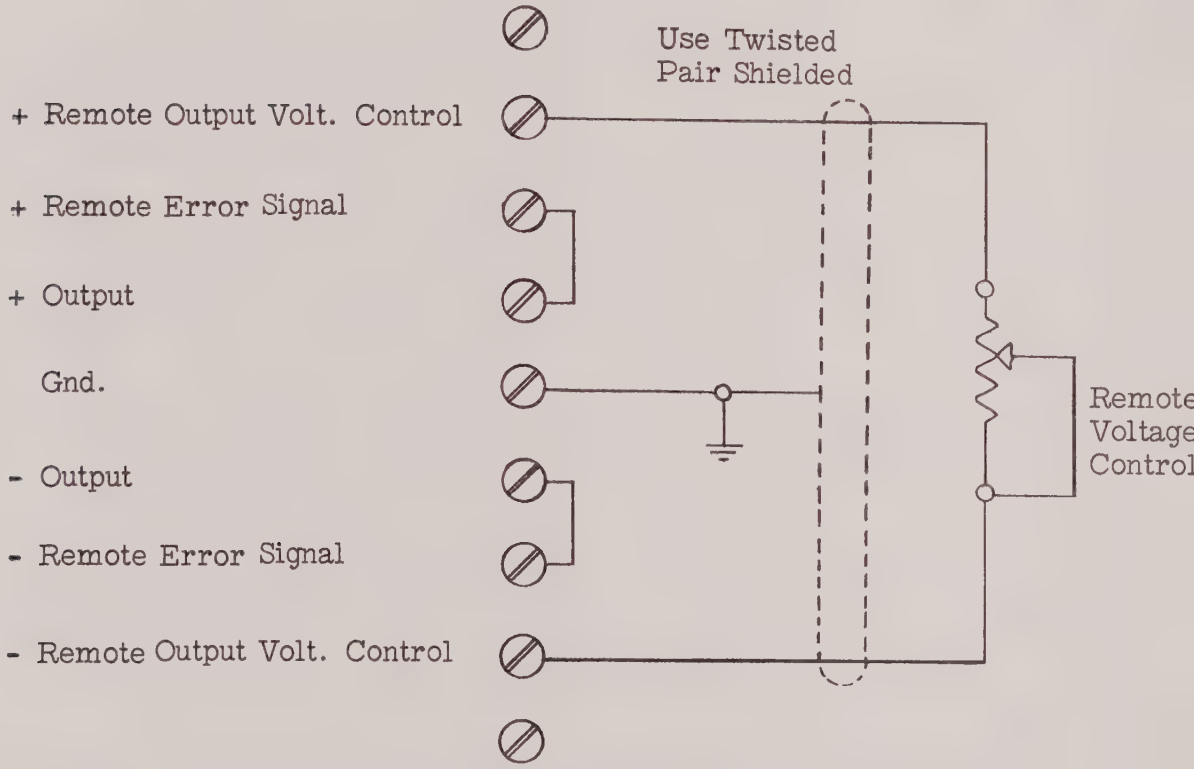


1. With A.C. input power disconnected, remove jumpers between OUTPUT terminals and REMOTE ERROR SIGNAL terminals.

2. Using twisted pair wire, connect sensing leads from positive and negative REMOTE ERROR SIGNAL terminals to the load (observe polarities).

3. Using twisted pair wire, connect load supply leads from positive and negative OUTPUT terminals.

CONVERTING TO REMOTE OUTPUT VOLTAGE CONTROL OPERATION

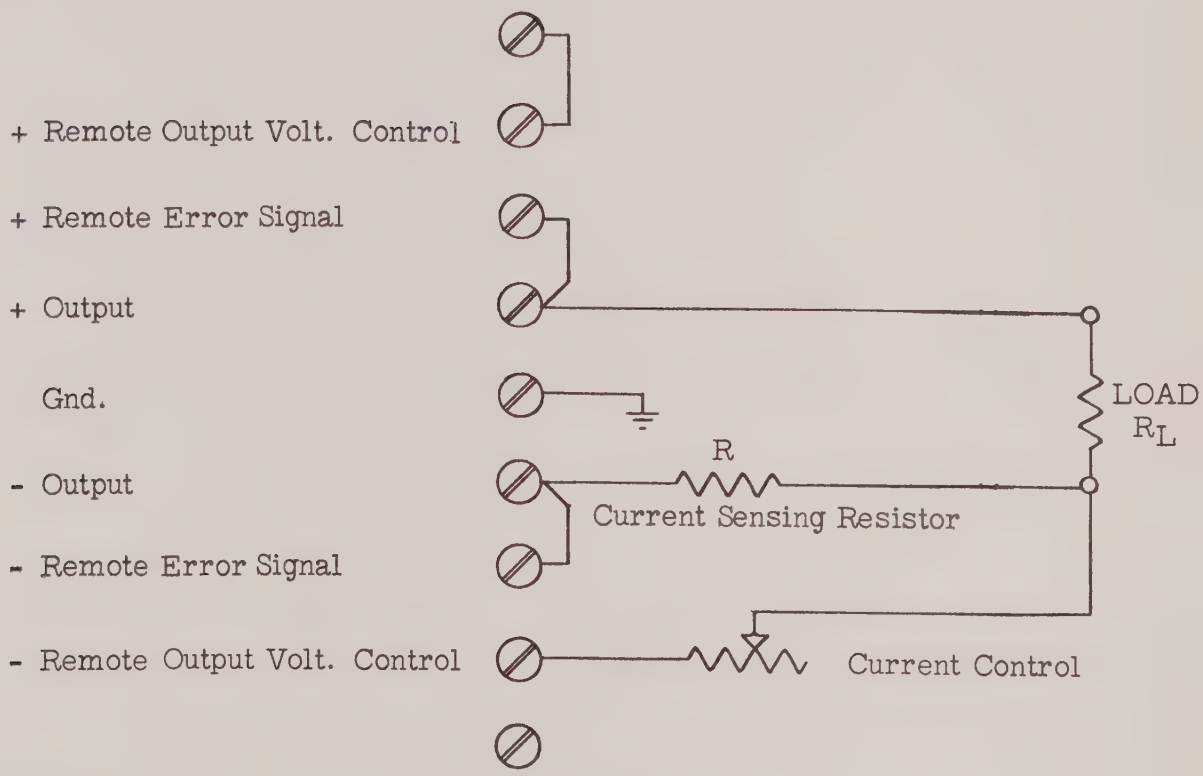


1. With A. C. power disconnected remove jumpers from positive and negative REMOTE OUTPUT VOLTAGE CONTROL terminals.

2. Connect shielded twisted pair wire leads from REMOTE OUTPUT VOLTAGE CONTROL terminals to remote control resistance (observe polarities).

3. The remote control resistance fixed or variable, must be equal to the product of the desired output voltage and the ohms/volt ratio specified for this model in Section A.

CONVERTING TO CURRENT REGULATED OPERATION



1. Remove jumper from negative REMOTE OUTPUT VOLTAGE CONTROL terminal.

2. Connect a current control resistor from the negative REMOTE OUTPUT VOLTAGE CONTROL terminal to the load. Observe polarities. This resistance should be equal in ohms, to the ohms/volt ratio specified for this unit in Section A.

3. Connect a current sensing resistor in series with the external load R_L. The value of this resistor is chosen to give a drop of one volt at maximum desired output current.

$$R = {}^{1}/\text{max. output amps.}$$

SECTION D

MAINTENANCE AND REPAIRS

.....GENERAL:

(1) In servicing this equipment it should be remembered that the essential regulating circuitry is a closed loop DC servo system. Careless servicing may affect the whole system. The same circuit sensitivity which enables a high degree of regulation to be obtained also increases the susceptibility of the circuit components to interrelated functional disorders when the equipment is abused. No component is an "island entire in itself". Consequently, exercise the greatest care in making repairs.

(2) Before any systematic trouble-shooting is attempted, it is advisable to establish by careful examination whether any malfunction is attributable to "simple" mechanical disorders: broken leads, loose plugs, etc. Obviously, many "simple" disorders may be symptomatic, that is, effects rather than causes of equipment malfunction.

(3) The components of this power supply have been tested and selected to provide long and trouble free operation. Under normal operating conditions, maintenance will consist merely in oiling the fan every six months. However, if component failure occurs the unit should be serviced by personnel who are thoroughly familiar with transistor circuitry. SERIOUS, COSTLY DAMAGE CAN RESULT FROM CARELESS PROBING.

(4) PARTS LOCATION: New, revised, Instruction Manuals include Parts Location Photos. These photos together with schematic diagrams should facilitate trouble-shooting and replacement.

(5) CONTROL UNITS: Control Units or "TRAMS" are of a semi-modular plug-in design. (However, it is necessary, according to the particular model, to remove bracket screws or stand-off screws before the CONTROL UNITS can be unplugged.)

.....PRECAUTIONS:

(1) CHECK ALL TRANSISTORS BEFORE REPLACING ANY. IF ASSOCIATED TRANSISTORS ARE DEFECTIVE, THE REPLACEMENT MAY BE IMMEDIATELY RUINED.

(2) IF MAJOR REPAIRS ARE NECESSARY, THE FACTORY IS PREPARED TO HANDLE THEM. UNDER NO CIRCUMSTANCES SHOULD THE UNIT BE RETURNED TO THE FACTORY WITHOUT PROPER AUTHORIZATION AND SHIPPING INSTRUCTIONS. IN ANY CORRESPONDENCE WITH THE FACTORY CONCERNING REPAIRS, THE MODEL AND SERIAL NUMBER OF THE UNIT MUST BE GIVEN TOGETHER WITH A DESCRIPTION OF THE TROUBLE ENCOUNTERED.

(3) Check all fuses before applying power after any repairs or replacements have been made.

(4) If it is found that the output voltage cannot be varied over its entire range by means of the voltage control adjustment, be careful not to short the supply as severe damage to the unit may result. In this regard, if it is detected that the output voltage does not decrease as the

voltage control is turned counter-clockwise, DO NOT CONTINUE TO TURN THE CONTROL.

(5) If it is necessary to solder transistor terminals, it is recommended that the leads be held with pliers between the transistor and the point to be soldered in order to shunt heat and reduce the possibility of damage to semi-conductor junctions. This applies as well to semi-conductor diodes.

.....CHECKING TRANSISTORS:

(1) Since a transistor is essentially a combination of semi-conductor diodes, a short in both directions between any two of its terminals is sufficient indication that the transistor is defective. Characteristically, the ratio of the forward to the reverse resistance across a transistor junction should be at least 100. In the majority of cases, the bi-directional short will occur between the collector and emitter terminals. Occasionally, a short will occur between the base and either of the other two terminals, but this condition is usually compounded with an emitter-collector short.

(2) HIGH POWER TRANSISTORS - If possible, a power transistor checker should be employed, but on a Go-No-Go basis an ohmmeter will prove adequate to detect defective components. USING THE RX1 SCALE OF THE OHMMETER, TEST FOR SHORT WITH ONE POLARITY; REVERSING POLARITIES, TEST FOR SHORT IN THE REVERSE DIRECTION. PASS TRANSISTOR groups containing elements in parallel may be checked collectively without removal from the circuit. This is done by connecting an ohmmeter directly across the collector emitter terminals

of the pass elements. If any one of the transistors in parallel is shorted, the group will, of course, be shorted and require individual checking.

NOTE: PASS TRANSISTORS are mounted in most models on the chassis in plug-in heat sinks called "STATS". In early models these STATS could be disconnected simply by pulling the STAT plug from its socket. In the newer models, for increased structural rigidity, the STATS are fastened by self-tapping hex-head screws which must be removed from the underside of the chassis.

(3) LOW POWER TRANSISTORS - Can be adequately tested using standard "packaged" transistor checkers (e.g. Baird-Atomic Beta-h_{11} Model KT-1, Barber Labs. Junction Transistor Checker Model #29). IMPORTANT: BE SURE THE PNP-NPN SELECTOR SWITCH IS IN THE CORRECT POSITION.

NOTE: Associated with each PASS TRANSISTOR connected in parallel within a pass group is a low-value resistor, called an "equalizing resistor", which operates to equalize current distribution among the pass elements. It should be ascertained whether or not a defective equalizing resistor is contributing to or has resulted from operational disorders. If one of these resistors "burns open" it effectively removes a pass transistor from the main circuit and increases the dissipation requirements of the remaining elements.

.....REGULATION:

(1) GENERAL - The regulation of this unit has been precisely measured and found to conform to specification. It must be emphasized that when the regulation specification is of a low order of magnitude great care must be exercised in proceeding to verify this measurement. Otherwise, inaccuracies may be introduced by the test. For example: a full load current drawn through an uncompensated internal resistance of 0.0002 ohm in a 32 volt-15 ampere, 0.01% regulated power supply operating at maximum voltage will produce a voltage drop equal to the % regulation specification. This amount of resistance might easily be introduced by improper setup connections for regulation measurement.

(2) DEFINITIONS -

Line Regulation is specified as the % change in output voltage as the line voltage is varied from minimum to maximum or vice versa, with the load held at a constant value.

Load Regulation is specified as the % change in output voltage as the load is varied from minimum to maximum or vice versa, with the line voltage held at a constant value.

(3) INSTRUMENTATION -

a) A differential voltmeter or Kepco Regulation Analyzer 901B can be used to measure regulation.

The output may also be monitored by a DC coupled oscilloscope provided a buck-out device is employed. The buck-out source should be of a better order of regulation than the

power supply being tested, and for maximum sensitivity the buck-out source should provide a voltage of magnitude comparable to the output setting of the supply being tested.

b) A Variac or line voltage adjuster (e.g. Kepco Model 920B) and an AC voltmeter (e.g. Weston or equivalent) can be used to control and measure the line voltage.

c) Variable Load Resistance.

(4) CONNECTIONS - A major source of inaccuracy in measuring regulation is uncompensated voltage drops due to improper connections. Regulation should be measured at the Remote Error Signal or Output Terminals on the terminal board with the load taken from either front or rear output terminals.

IT IS STRONGLY RECOMMENDED THAT CONNECTIONS FOR THE INSTRUMENTATION SET-UP FOR MEASURING REGULATION BE MADE BY LOOPING #14 BUSS AROUND the Remote Error Signal or Output terminal SCREWS ON THE TERMINAL BOARD (with jumpers in place). (See Diagram following this section.)

(5) CAUTION -

a) To prevent possible deterioration of regulation due to voltage drops across the internal buss connecting front and rear output terminals, avoid measuring regulation at the front terminals when the load is taken from the rear output.

b) When the load is remotely located with respect to the power supply or load current requirements are high, voltage drops

across output leads must be compensated for by converting to Remote Error Signal operation. (See Section C of this manual)

c) If the load is split between the front or rear output terminals, the load at the rear will receive the best regulation, the front output voltage being higher by the amount of voltage drop in the internal buss.

.....FACTORY RETURNS:

It is important that units returned to Kepco for repair be tagged with a brief description of the defects observed by the customer.

This will greatly facilitate the recording, handling and scheduling necessary to expedite servicing.

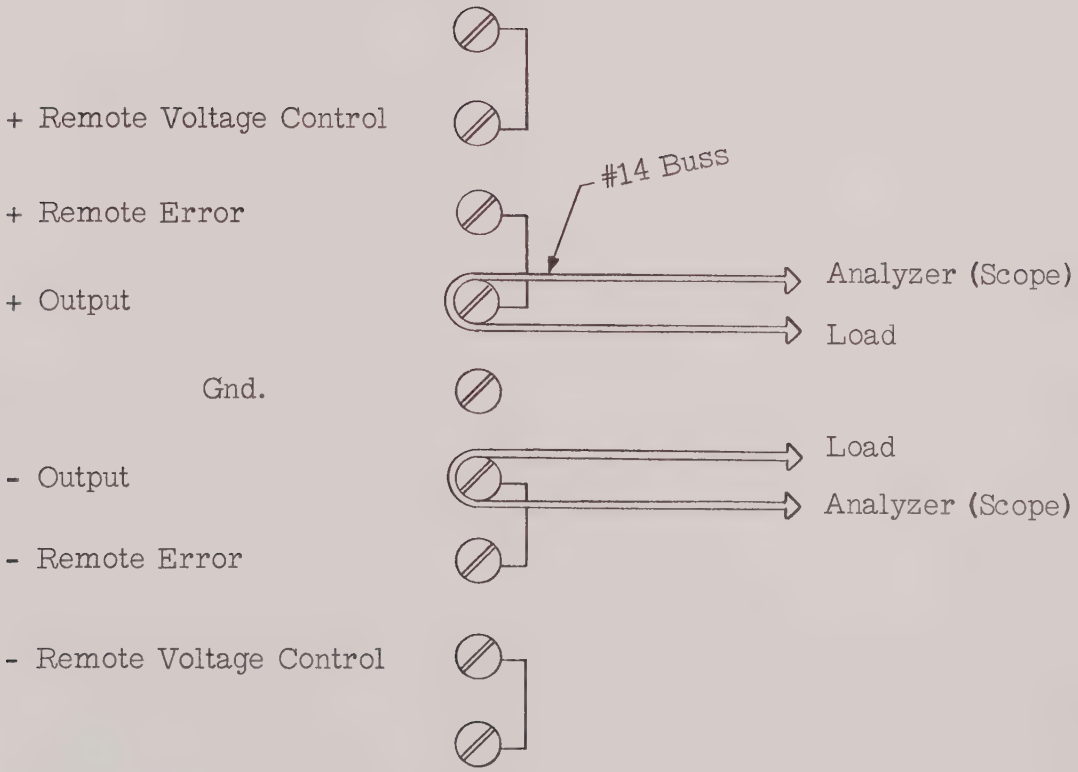
Under no circumstances should the unit be returned to the factory without proper authorization and shipping instructions. In any correspondence with the factory concerning repairs, the model and serial number of the unit must be given.

Cause numbers indicate order of probability

TROUBLE-SHOOTING CHART

SYMPTOM	CAUSE
A. NO OUTPUT	1. Overtemperature relay activated by: a. blocked ports b. ambient temperature too high c. defective fan d. defective relay 2. Input fuse blown by short in: rectifiers, transformer, main supply filter capacitor 3. Defective Control Unit (TRAM) 4. Defective ammeter
B. NO REGULATION HIGH OUTPUT VOLTAGE; VOLTAGE CONTROL DOES NOT DECREASE OUTPUT VOLTAGE (EXCEPT IN VARIAC UNITS).	1. Defective pass elements 2. Open Voltage Control Potentiometer 3. Defective Control Unit (TRAM) 4. Defective Driver or Pre-Driver associated with Pass Transistors
C. NO REGULATION LOW OUTPUT VOLTAGE	1. Current Limit Adjust set too low 2. Defective Control Unit (TRAM) 3. Incorrect conversion to remote error operation 4. Defective Main Filter capacitor

CONNECTIONS FOR REGULATION MEASUREMENT



PARTS LIST

DRAWING S-TRAM-4-01

C1	- 2	MF	200 WV
C2	- 0.4	MF	50 WV
C3	- 25	MF	25 WV
C4	- 0.1	MF	500 WV
CR1	- Germanium Diode 1N91		
Q1	- Transistor 2N441		
Q2 thru Q6	- Transistor 2N382 (Alternate 2N383)		
Q7	- Transistor 2N35 (Alternate GT-1092)		
Q8	- Transistor 2N382 (Alternate 2N383)		
Q9	- Transistor GT-1092		
Q10	- Transistor 2N35 (Alternate GT-1092)		
R1	- 3.3	K	1/2 watt
R2	- 2.2	K	1/2 watt
R3	- 500	Ohm	3 watt WW
R4	- 500	Ohm	3 watt WW
R5	- 4.7	K	1/2 watt
R6	- 2.5	K	3 watt WW
R7	- 2.5	K	3 watt WW
R8	- 10	K	3 watt WW
R9	- 2.5	K	3 watt WW
R10	- 500	Ohm	3 watt WW
R11	- 100	Ohm	3 watt WW
R12	- 100	Ohm	3 watt WW
R13	- 1.8	K	1/2 watt WW
R14	- 10	Ohm	1/2 watt
R15	- 1.5	K	1/2 watt
R16	- 1.8	K	1/2 watt
R17	- 1.5	K	1/2 watt
R18	- 220	Ohm	1/2 watt
R19	- 1.5	K	1/2 watt
R20	- 1.5	K	1/2 watt
R21	- 2.7	K	1/2 watt
R22	- 10	Ohm	1/2 watt
R23	- 100	Ohm	1 watt
R24	- 500	Ohm	2 watt Pot.
R25	- 500	Ohm	2 watt Pot.
R26	- 200	Ohm	3 watt WW
RD1	- Diode 1N429		

PARTS LIST - MODEL SC-32-0.5

DRAWING S-SC-32-0.5-02

B201	- Fan		
C201	- 3300	MF	50 WV
C202	- 2000	MF	80 WV
C203	- 60	MF	250 WV
C204	- 350	MF	50 WV
C205	- 500	MF	12 WV
C206	- 500	MF	12 WV
C207	- 100	MF	12 WV
C208	- 100	MF	12 WV
C209 thru C211	- 0.22	MF	200 WV
C212	- Omitted		
C213	- 0.05	MF	500 WV
C214	- 0.1	MF	500 WV
C215	- 0.22	MF	200 WV
CR201 and CR202	- Silicon Rectifier AM-21		
CR203 and CR204	- Silicon Rectifier PT-5		
CR205 thru CR212	- Germanium Rectifier 1N91		
F101	- 2 Amp. Fuse		
F201 and F202	- 1/4 Amp. Fuse		
M101	- Meter, 0-500 MA DC		
M102	- Meter, 0-50 V DC		
PL101	- Neon Pilot Light NE-51		
Q201 and Q202	- Transistor 2N382 (Alternate 2N383)		
Q901 thru Q904	- Transistor 2N441-6		
R101	- 10	K	10 turn Pot.
R201	- 500	Ohm	40 watt WW
R202	- 1.5	Ohm	3 watt WW
R203	- 1	K	1/2 watt
R204	- 2	K	1 watt
R205	- 2.2	K	1 watt
R206	- 1	K	1/2 watt
R207	- 2.2	K	2 watt
R208	- 120	Ohm	1 watt

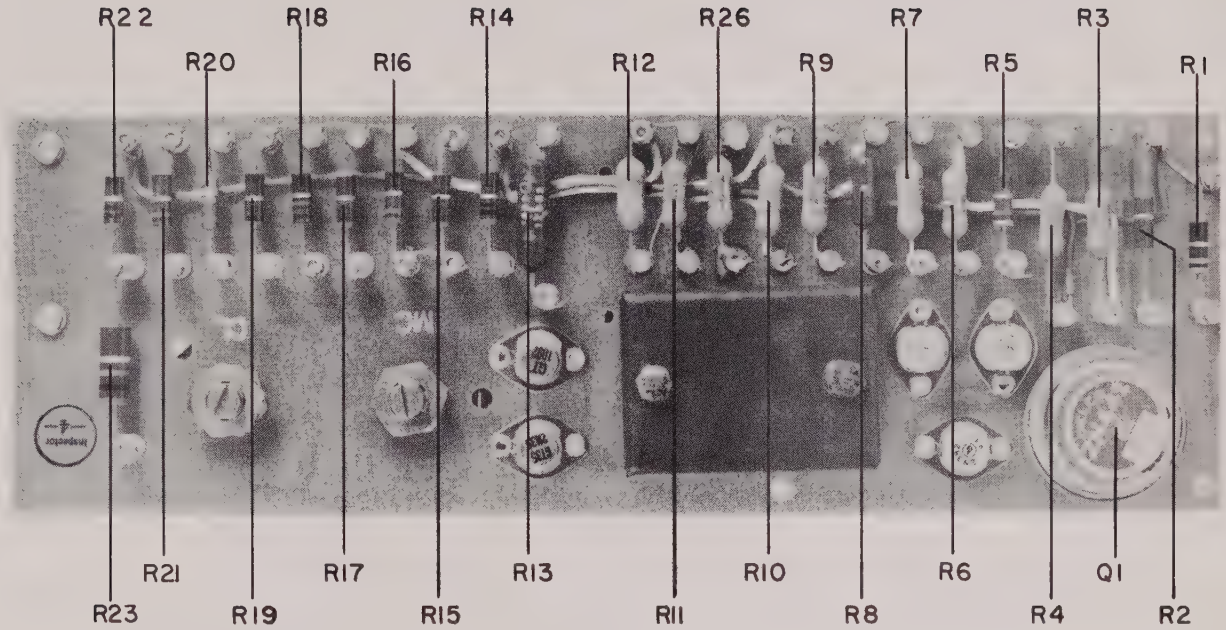
PARTS LIST - MODEL SC-32-0.5

DRAWING S-SC-32-0.5-02

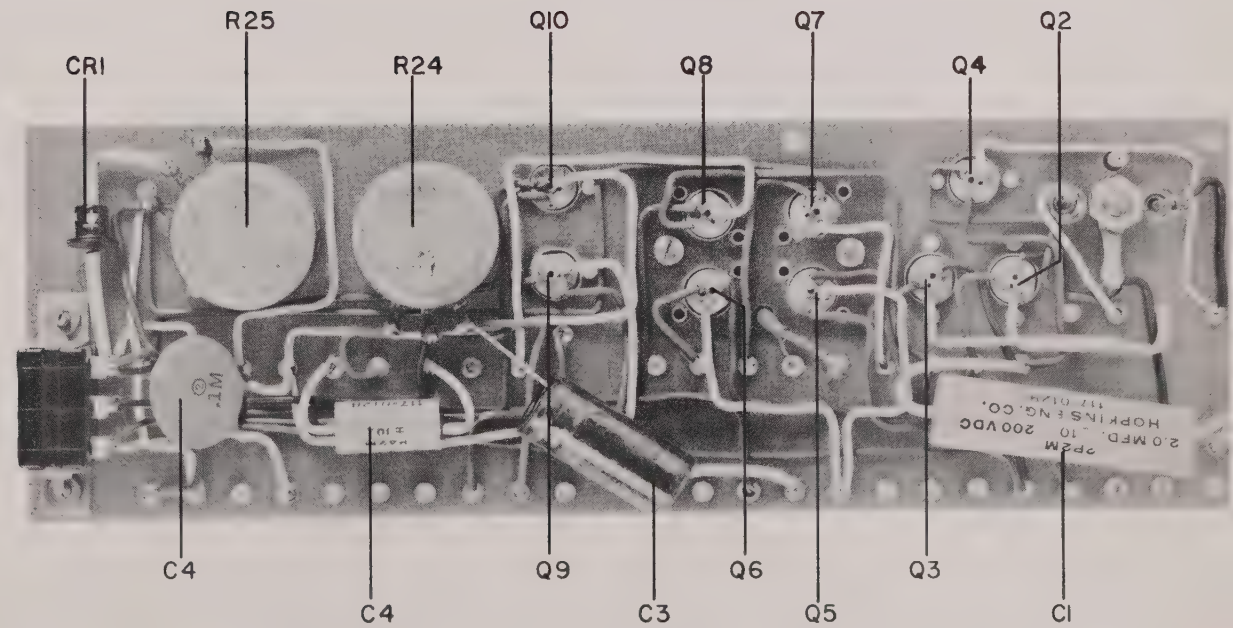
R209	-120	Ohm	1 watt
R210	- 39	Ohm	1/2 watt
R211	- 500	Ohm	20 watt
R212	- 47	Ohm	1/2 watt
R901 and R902	- 1.5	Ohm	3 watt WW

RL201	- DPDT Relay
RL202	- DPDT Relay
S101	- DPDT Switch
S201	- Thermoswitch N. O.
T201	- Kepco #100-1052
T202	- Kepco #100-1039
TB201	- Jones #9-140-Y

TOP

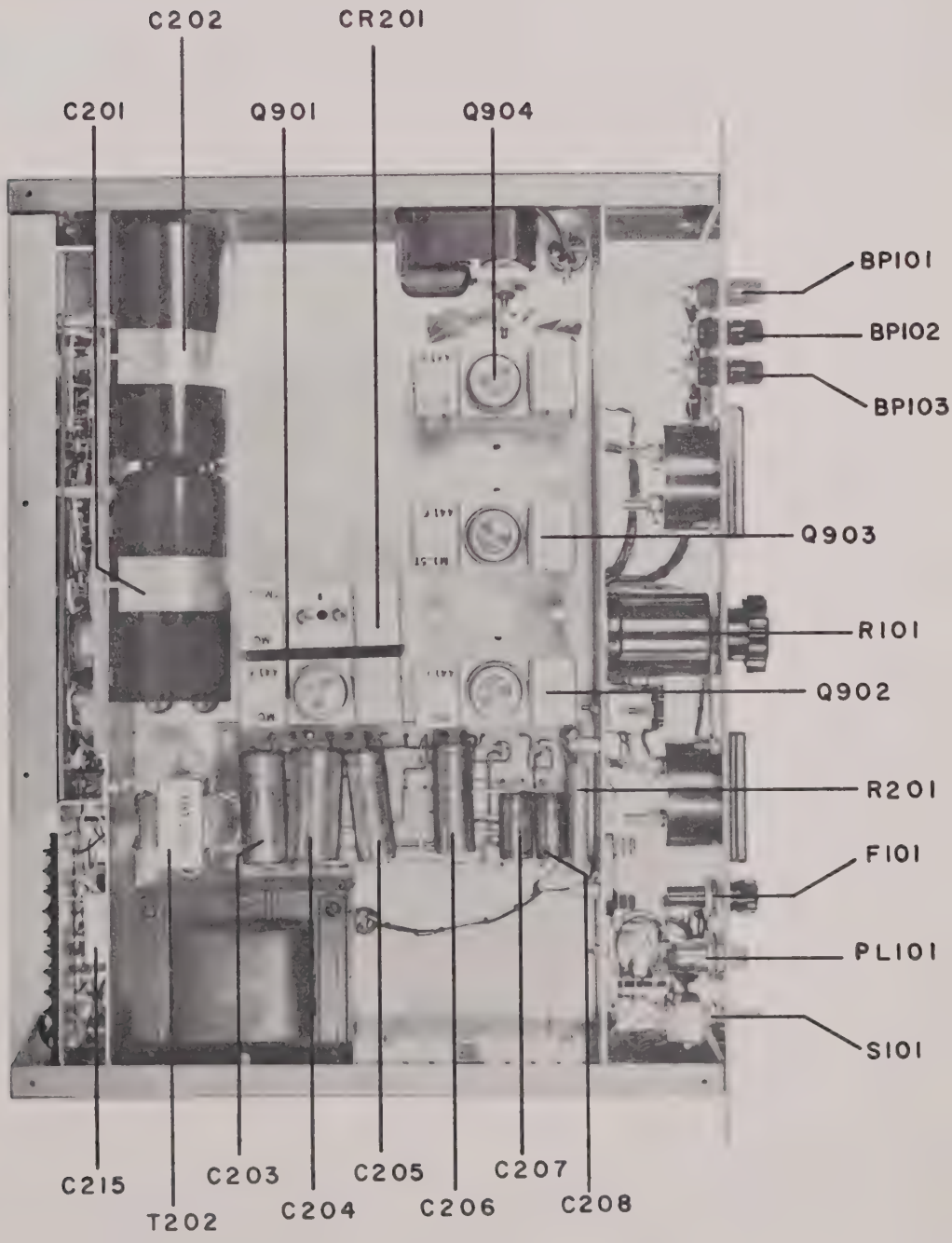


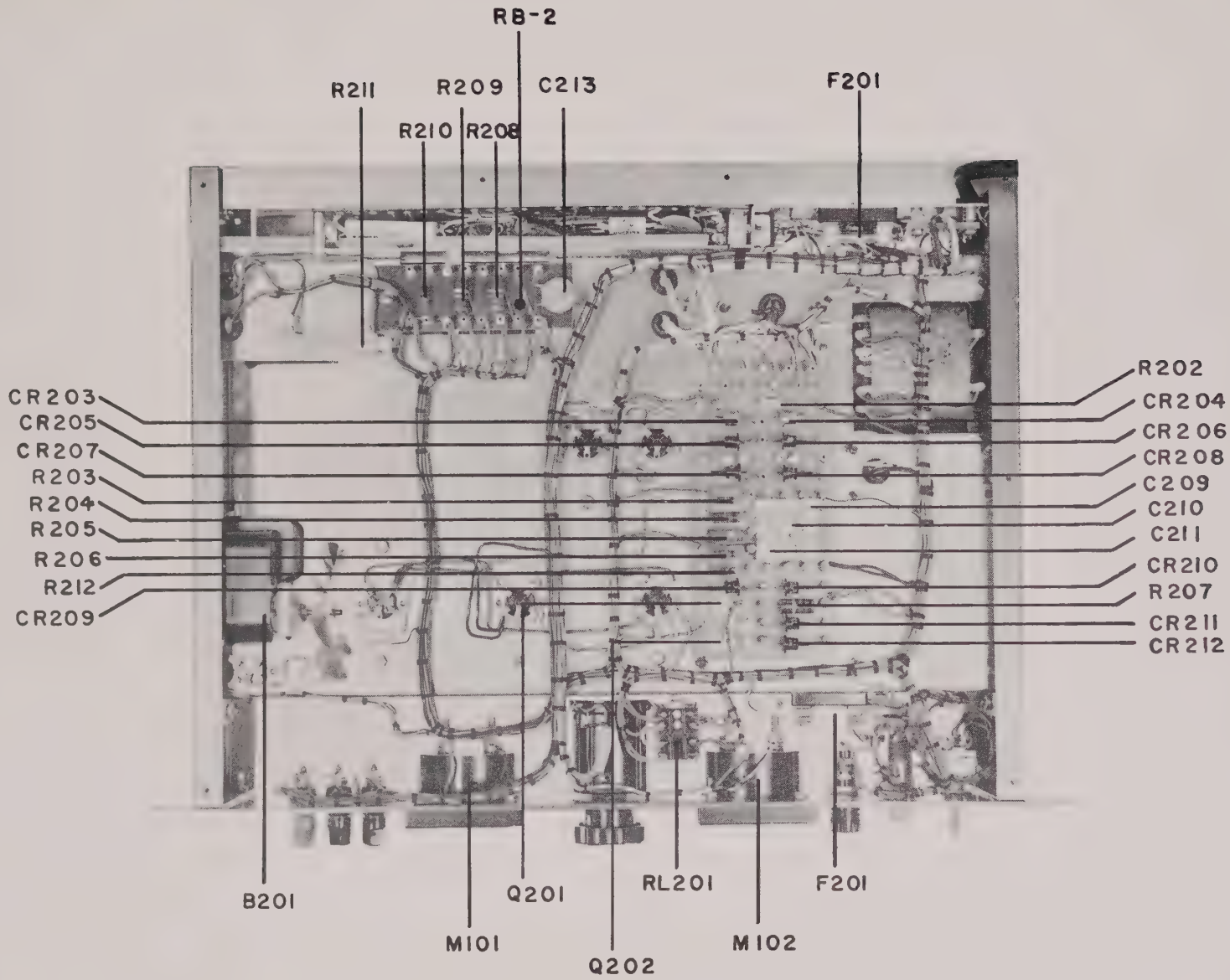
REAR



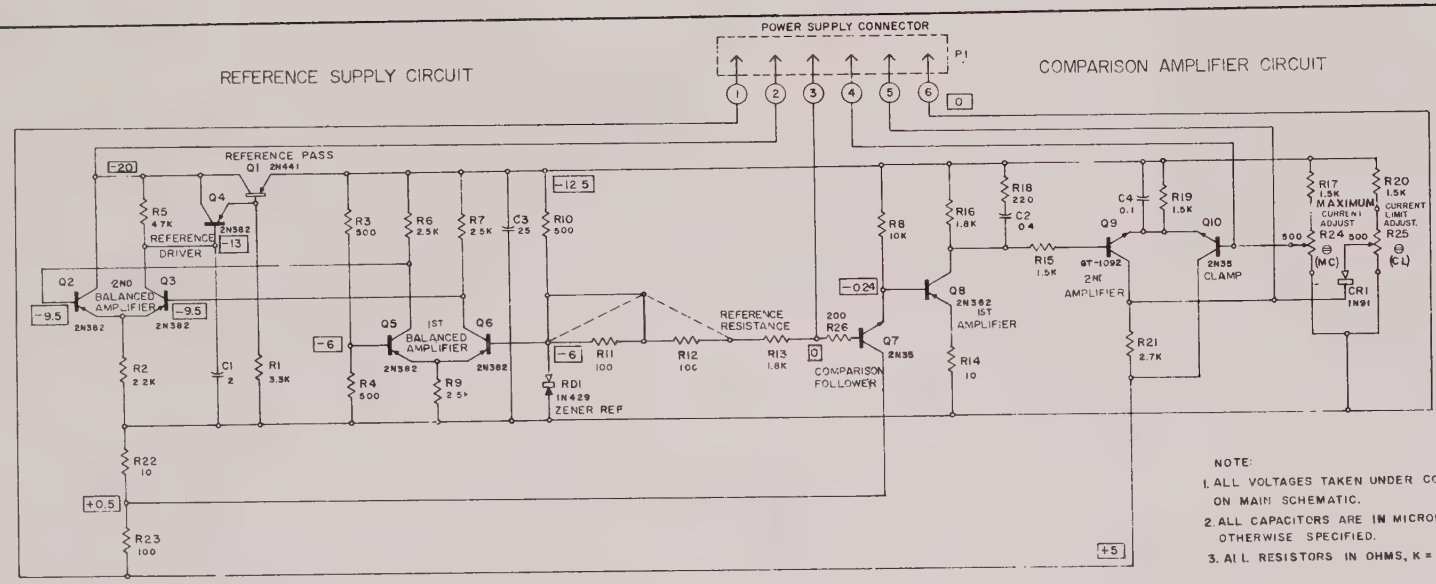
TRAM-4

SC-32-0.5 TOP


C202
CR201
C201
Q901
Q904
BP101
BP102
BP103
Q903
R101
Q902
R201
F101
PL101
S101
C215
T202
C203
C204
C205
C206
C207
C208



SC-32-0.5 BOTTOM



NOTE:

1. ALL VOLTAGES TAKEN UNDER CONDITIONS SPECIFIED ON MAIN SCHEMATIC.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL RESISTORS IN OHMS, K = 1,000 OHMS.

KEPCO LABORATORIES

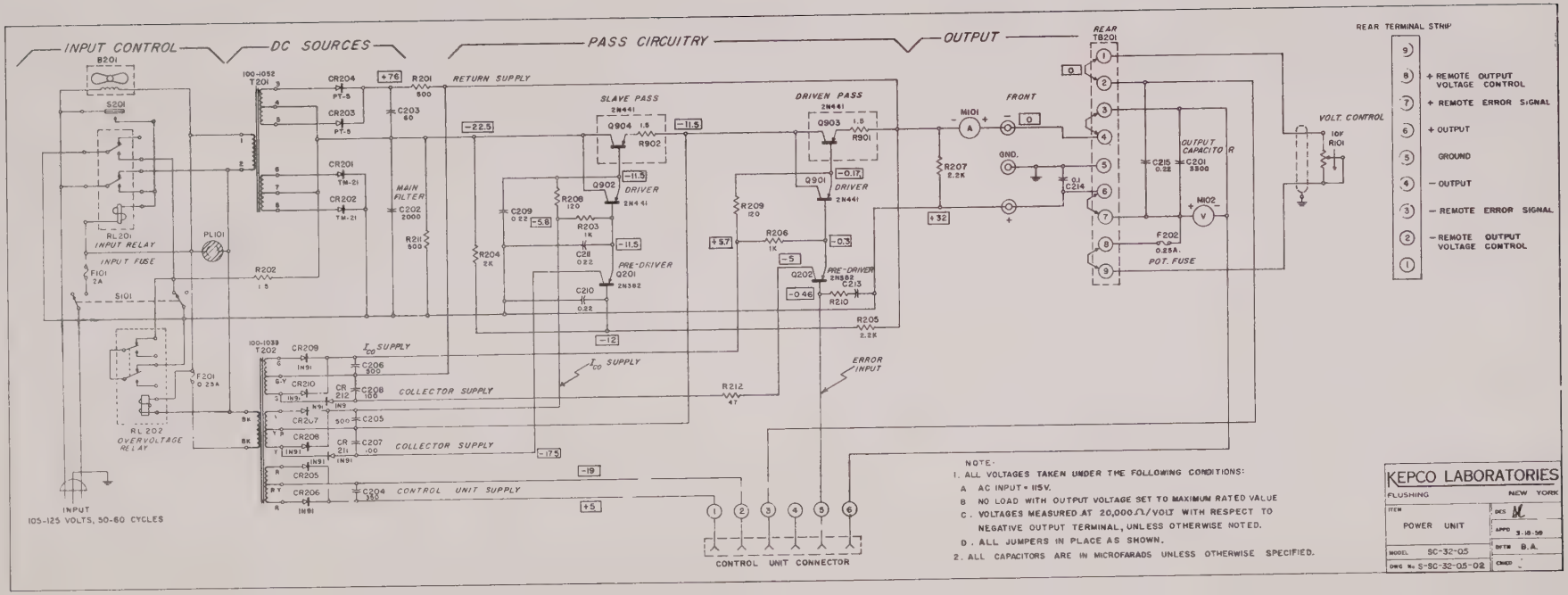
FLUSHING NEW YORK

ITEM CONTROL UNIT

DATE 11-13-59

MODEL TRAM-4

DRWG. No S-TRAM-4-01



NOTE:
1. ALL VOLTAGES TAKEN UNDER THE FOLLOWING CONDITIONS:
   A. AC INPUT = 115V.
   B. NO LOAD WITH OUTPUT VOLTAGE SET TO MAXIMUM RATED VALUE
   C. VOLTAGES MEASURED AT 20,000Ω/VOLT WITH RESPECT TO NEGATIVE OUTPUT TERMINAL, UNLESS OTHERWISE NOTED.
   D. ALL JUMPERS IN PLACE AS SHOWN.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

KEPCO LABORATORIES
FLUSHING NEW YORK

ITEM: POWER UNIT	DES: M
	APPD: 3-18-59
MODEL: SC-32-05	DRTR: B.A.
DWG No. S-SC-32-05-02	CHKD:

first in
Performance
Reliability
and Quality
Kepco